(11) (A) No. 1026252

(45) ISSUED 780214

(52) CLASS 196-22
C.R. CL.

(19) (CA) # CANADIAN PATENT

(54) CYCLONING AND FILTRATION OF BITUMEN FROTH

(70) Lupul, Silver and Ross, John D.,
Canada

Granted to Her Majesty the Queen in right of Canada, as represented by the Minister of Energy, Mines and Resources; Her Majesty the Queen in right of the Province of Alberta; Ontario Energy Corporation; Imperial Oil Limited; Canada-Cities Service, Ltd. and Gulf Oil Canada Limited and Atlantic Richfield Canada, Ltd., Canada

(21) APPLICATION No. 194, 142
(22) FILED 740305

(30) PRIORITY DATE

No. OF CLAIMS 3

"CYCLONING AND FILTRATION OF BITUMEN FROTH"

ABSTRACT OF THE DISCLOSURE

Diluted bitumen froth, comprising bitumen, hydrocarbon diluent, water and fine and coarse solids, is subjected to centrifugal separation in a cyclone separator. An overflow product comprising bitumen, hydrocarbon diluent, water and fine solids is produced. This product is substantially free of coarse solids. The underflow stream from the cyclone separator, which comprises some bitumen and hydrocarbon diluent, water and coarse and fine solids, is filtered to separate the solids from the liquids. The liquids are then preferably recycled to the cyclone separator for recovery of contained bitumen and diluent hydrocarbon. The overflow product from the separator is advanced to a disc-type centrifugal separator to separate the hydrocarbons from the water and solids.

A

This invention relates to a process for extracting bitumen from tar sand. More particularly, it relates to a process for upgrading a diluted bitumen froth stream by the removal of coarse solids therefrom.

A large proportion of the world's known hydrocarbon reserves exists in the form of tar sand. One large deposit of this material is found along the banks of the Athabasca River in Alberta. The tar sand exists in the form of water-wet grains of sand sheathed in films of bitumen. In treating the tar sand to recover commercially useful products, it is first necessary to separate the bitumen from the water and sand.

The method commonly employed to extract the bitumen is known as the hot water process. In the first step of this process, tar sand, hot water, and steam are fed into a rotating tumbler and mixed therein. The hot water is supplied at a temperature of about 180°F and in an amount sufficient to produce a slurry containing about 20% - 25% by weight water. The residence time within the tumbler is approximately four minutes and the exit temperature of the slurry is about 180°F. While in the tumbler, the tar sand disintegrates.

The tumbler product is passed through a screen to remove lumps and rocks and is then flooded with additional hot water to further disperse the sand and bitumen particles. A typical flooded slurry will have a composition of 7% bitumen, 43% water and 50% solids, and a temperature of 160°F - 180°F. (All percentage values in this disclosure indicate percent by weight).

The flooded slurry is then fed continuously into a primary separation vessel or cell. This cell is a cy-

lindrical settler having a conical bottom. In the cell, the sand particles, particularly the coarse particles, fall to the bottom and leave through an outlet as a tailing stream. Most of the bitumen particles rise to the top of the cell and form bitumen froth. This froth overflows the cell wall into a launder for removal.

A typical primary froth product comprises 66.4% bitumen, 8.9% solids, and 24.7% water.

A middlings stream, typically comprising 76.8% water, 21.0% silt and fine clay particles, and 2.3% bitumen, is continuously withdrawn from the intermediate zone of the primary cell. The purpose of withdrawing this middlings stream is twofold - to remove excess water from the cell, and to maintain the concentration of fines in the cell low enough to permit the bitumen to rise and form froth at a reasonable rate. The middlings stream is treated in a sub-aerated flotation cell and a cleaner to recover contained bitumen as secondary froth. This secondary froth typically comprises 41.4% bitumen, 46.2% water, and 12.4% solids. A secondary tailings stream, comprising water, solids and a trace of bitumen, is produced from the bottom outlet of the secondary recovery cell.

The combined froth product, comprising the primary and secondary froths, typically contains 62.5% bitumen, 28.4% water and 9.1% solids. Of the total solids in the combined froth, approximately 55% are smaller than 44 microns in size and 45% are larger. The +44 micron particles are referred to hereinafter as "coarse" solids, and the -44 micron particles are referred to as "fine" solids.

The combined froth is treated to remove solids and water. Conventionally this is done by: (1) diluting

A

the froth with a hydrocarbon diluent, such as naphtha, to increase the specific gravity differential of the bitumen relative to the water, and to reduce the oil phase viscosity, so as to make the mixture amenable to centrifugal separation; (2) passing the diluted stream through a solid bowl scroll centrifuge to remove the coarse solids; and (3) passing the liquid stream from the scroll machine through disc-type centrifugal machines to remove the water and fine solids.

The presently utilized solid bowl scroll centrifuges have a serious drawback. Because they involve moving parts, they are subject to erosion by the abrasive sand moving through them. The maintenance cost associated with these machines in this service is therefore high.

In accordance with the present invention, a bitumen froth stream, diluted with a hydrocarbon diluent is subjected to centrifugal separation in a cyclone separator. The separator's overflow stream is found to comprise bitumen, hydrocarbon diluent, water and fine solids, and is substantially free of coarse solids. The separator's underflow stream is a mixture of water, coarse solids, bitumen and hydrocarbon diluent. This underflow stream is amenable to treatment, such as filtration, whereby the coarse solids may be separated from the liquid. The liquid product from the filter is preferably recycled to the cyclone separator to recover contained hydrocarbons. The overflow stream from the cyclone separator provides a desirable feed for processing in a disc-type centrifuge separator, for separation of the bitumen from the water and solids.

The process is characterized by substantially complete separation of the coarse solids from the main bitumen stream, with greatly reduced erosion of the equip-

ment in comparison to the prior art method.

Broadly stated, the invention is a method for upgrading a diluted bitumen froth stream which has not been thermally dehydrated and which contains bitumen, hydrocarbon diluent, water, and fine and coarse solids, which comprises: subjecting the froth stream to centrifugal separation in a cyclone separator to produce an overflow stream which is substantially free of coarse solids and comprises bitumen, hydrocarbon diluent, water and fine solids, and an underflow stream which comprises a mixture of bitumen, hydrocarbon diluent, water and coarse and fine solids; and advancing the overflow stream from the cyclone separator to a disc-type centrifugal separator for separation of the bitumen from the water and solids.

DESCRIPTION OF THE DRAWING

The drawing is a schematic diagram illustrating the process.

DESCRIPTION OF THE PREFERRED EMBODIMENT

This process and its benefits are illustrated in the following example, which is to be read in conjunction with the drawing.

The combined froth feed stock 1, at a temperature of 160°F, is fed to a deaerator vessel A. In this vessel A, the froth 1 is contacted with steam 2 to increase the froth temperature to 195°F - 200°F, thereby releasing the air from the bitumen.

The deaerated froth 1a leaves vessel A and flows into surge tank B. From the surge tank B, the froth 1a is pumped by a pump C through an in-line mixer D to a cyclone E. Naphtha 3, a hydrocarbon with a boiling range of approximately 180°F - 380°F, or a like hydrocarbon diluent, is added to the froth stream 1a ahead of the mixer D in a proportion which will yield the desired specific gravity and viscosity of the combined hydrocarbon phase. The mixer D promotes solution of the naphtha 3 in the deaerated bitumen froth 1a, yielding a stream 7.

The cyclone E is of conventional design. A 2½ inch diameter cyclone with 3/8 inch diameter inlet opening, 3/4 inch overflow opening, 1/4 inch underflow opening, and 10° included cone angle processes a typical froth mixed with a diluent of boiling range 380°F - 610°F to yield the following:

CONDITIONS OF TESTS

Cyclone Pressure Drop psi	Flow Rates (lbs/min.) Feed	Underflow	Feed Temperature °F
28	244	44	194
90	398	60	194

ANALYTICAL RESULTS

FEED (7) COMPOSITION				OVERFLOW (5) COMPOSITION			UNDERFLOW COMPOSITION		
Hydrocarbon Wt. %	Water Wt. %	Solids Wt. %	Hydrocarbon Viscosity*	Hydrocarbon Wt. %	Water Wt. %	Solids Wt. %	Hydrocarbon Wt. %	Water Wt. %	Solids Wt. %
76.9	11.0	12.1	52	85.0	10.3	4.7	42.1	19.9	38.0
78.7	10.9	10.4	52	87.2	9.0	3.8	20.7	17.8	61.5

* Viscosity in Redwood No. 1 seconds @ flowing conditions.

To recover the hydrocarbon from the cyclone underflow 8, this stream flows to storage vessel F; from there it is pumped by pump G to vacuum filter H, where the solids are collected on a wire cloth while the liquids, water and hydrocarbons, pass through. Conventional equipment common in industry is applicable to accomplish this function. Various configurations are available, such as drum, disk or pan vacuum filters, which are suitable. If desired, a naphtha wash or steam stripping operation can be used to further decrease the hydrocarbon content of the solids. The liquids 4 recovered by the filter H are returned to the cyclone feed 7 for reprocessing, while the solids 6 from the filter H are discarded as tailings.

Because of the nature of the solids in the cyclone underflow 8, the filtration rate should fall in the range of 100 - 500 pounds of solids per hour per square foot of filter area if the filter feed solids concentration is in excess of 50%. The filter collects the solids on a wire cloth which has 60 x 40 mesh openings. The solids form a cake comprising upwards of 80% solids with the balance being water and hydrocarbon. The amount of hydrocarbon remaining with the solids represents about 1% - 2% of the total hydrocarbon introduced to the cyclone E.

The overflow stream 5 from the cyclone E is preferably fed to a disc-type centrifugal separator J, for separation of the water and solids from the hydrocarbons. The hydrocarbon product from the separator J is in condition for processing in refinery-type operations.

Other variations in the specific details of the process described may be made without departing from the spirit of the invention, such embodiments of the invention

as come within the scope and purview of the appended claims are to be considered as part of this invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method for upgrading a diluted bitumen froth stream which has not been thermally dehydrated and which contains bitumen, hydrocarbon diluent, water, and fine and coarse solids, which comprises:

subjecting the froth stream to centrifugal separation in a cyclone separator to produce an overflow stream which is substantially free of coarse solids and comprises bitumen, hydrocarbon diluent, water and fine solids, and an underflow stream which comprises a mixture of bitumen, hydrocarbon diluent, water and coarse and fine solids; and

advancing the overflow stream from the cyclone separator to a disc-type centrifugal separator for separation of the bitumen from the water and solids.

2. The method as set forth in claim 1 comprising:

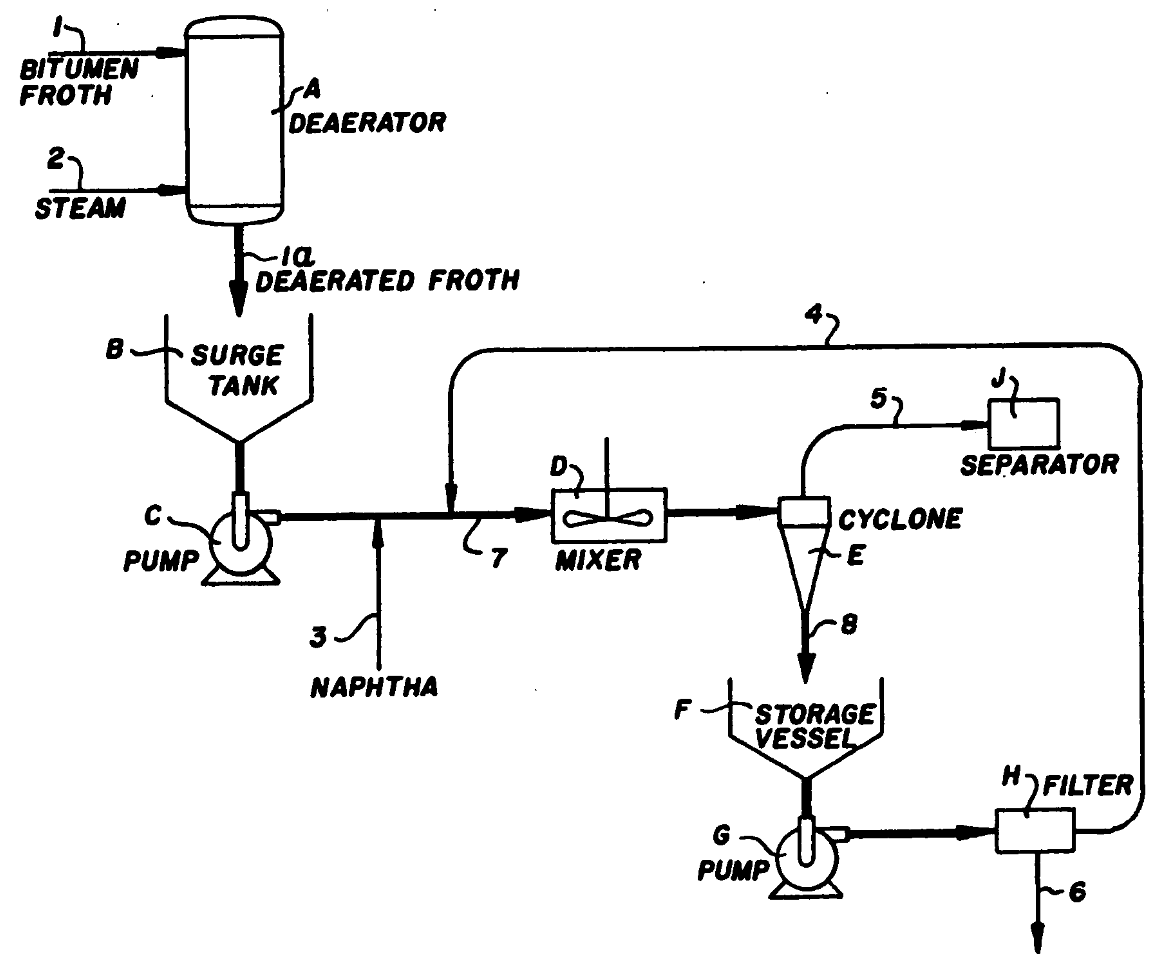
filtering the underflow stream to separate the solids and liquid fractions.

3. The method as set forth in claim 2 wherein:

the liquid fraction is recycled to the cyclone separator.

*

G



Inventors:
Silver Lupul
John D. Ross
Patent Agent:
Ernest Peter Johnson